

Literature

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WHITE PINE BLISTER RUST*

by W. V. Benedict

Pathogen

Cronartium ribicola Fischer.

Distribution

White pine blister rust is considered to be native to Asia from whence it spread to Europe about 1850 and to North America about 1900. It is now well established throughout most of the botanical range of the white pines in Canada and the United States -- from Quebec to British Columbia southward to North Carolina and California.

Hosts

The blister rust fungus lives alternately on white pines (five-needle pines) and plants in the genus *Ribes* (gooseberries and currants). It has been found on most white pines throughout the world. Some species are resistant but none is immune.

Pinaceae: (in order of relative susceptibility)

Native to North America

- Pinus albicaulis* Engelm. (whitebark pine)
- Pinus lambertiana* Dougl. (sugar pine)
- Pinus monticola* Dougl. (western white pine)
- Pinus flexilis* James (limber pine)
- Pinus strobus* L. (eastern white pine)
- Pinus flexilis* var. *reflexa* Engelm. (Mexican white pine)
- Pinus aristata* Engelm. (bristlecone pine)
- Pinus balfouriana* Grev. & Balf. (foxtail pine)

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Native to Europe and Asia

- Pinus excelsa Wall. (Himalayan pine)
- Pinus cembra L. (Swiss stone pine)
- Pinus parviflora Sieb. & Zucc. (Japanese white pine)
- Pinus koraiensis Sieb. & Zucc. (Korean pine)
- Pinus peuce Griseb. (Balkan pine)

Saxifragaceae

Ribes spp., about 200 species in Europe and North America. Among the more susceptible in North America are the following:

- Ribes bracteosum Dougl. (stink currant)
- Ribes cynosbati L. (pasture gooseberry)
- Ribes inerme Rydb. (white-stemmed gooseberry)
- Ribes lacustre (Pers.) Poir (prickly currant)
- Ribes nevadense Kell. (Sierra currant)
- Ribes nigrum L. (European black currant)
- Ribes petiolare Dougl. (western black currant)
- Ribes prostratum L'Her. (skunk currant)
- Ribes roezli Cov. & Brit. (Sierra gooseberry)
- Ribes sanguineum Pursh. (winter currant)
- Ribes viscosissimum Pursh. (sticky currant)

Life history

Infection on pine takes place during late summer and fall through the needles. The hyphae grow down the conducting tissue to the stem. Here the hyphae develop largely in the inner bark. After the mycelium has developed in the bark for about two to three years, pycnia appear. In the spring and early summer, following production of pycnia, aecia appear over the same area of bark. The aeciospores can retain their viability for several months under favorable conditions and for several weeks under unfavorable conditions. They are wind-borne, sometimes for several hundred miles, to infect ribes leaves. They cannot initiate infection on other pines. The germ tubes of the aeciospores enter the leaves through stomata on the undersurface. Within one to three weeks the uredia appear on the underside of the leaves. The uredia quickly rupture to release urediospores. Their function is to spread infection to nearby ribes. Seven generations or more of uredia may develop in a single summer. Following the uredia, either in the same or new lesions, telia develop usually in late summer or early fall. They appear as slender brown bristles on the underside of the leaf. Each telium is an aggregation of vertical rows of teliospores, which germinate in place by means of a five-celled promycelium, each of the four upper cells bearing one sporidium (basidiospore). The sporidia are then windborne to infect pine needles. They cannot infect ribes leaves. Sporidia are quite delicate, and the effective range at which pines can be infected is generally 900 feet. Aggregations of European black currant, western black currant, and perhaps other ribes species, may spread infection for as much as a mile or more under favorable conditions.

Description of damage

On pine, four to ten weeks after infection the disease first appears as small discolored spots on the needles. Twelve to eighteen months after infection, a yellowish to orange bark discoloration occurs at the base of the infected needle bundle. The discoloration spreads and the bark becomes swollen as the fungus grows. In late summer, twenty-two to twenty-four months after infection, the honey-colored pycnial drops appear. The next spring white blisters containing the orange-colored aeciospores push through the outer bark in the same places where the pycnial drops appeared the previous summer. The pycnial-aecial sequence is repeated each year as the perennial fungus advances through the bark.

After the aeciospores have been shed, the bark in the area of the blister darkens and becomes rough in texture. Continued growth of the fungus both up and down the branch or trunk produces a spindle-shaped canker. As the fungus invades living tissues, it kills them. Eventually the affected branch or trunk is girdled and dies. On branches killed, the needles turn a reddish copper color. They remain attached throughout the summer in which they die and often the following season.

On ribes, the first symptoms are the appearance of uredia on the underside of the leaves in the spring as small yellowish orange-colored dots. As the urediospores are released during the summer, the rust intensifies; more leaf area is covered with larger patches of uredia and more leaves on the same and other ribes plants are infected. The telia, appearing in late summer and early fall, are short, brownish, hairlike structures. On some ribes species, these telial columns are so numerous they form a brownish mat on the undersurface.

Present and potential impact

Blister rust kills white pines of all ages and sizes. The smaller the pines, the more quickly they are killed. In larger pines, trunk cankers girdle the trees, retard their growth, and so weaken the stems that the tops break at the point of girdling. Larger pines in the West are sometimes killed by multiple branch cankers. In unprotected areas the disease is preventing the natural restocking of white pines by killing the reproduction. In middle-aged stands blister rust infection, when not completely destructive, results in an undesirable thinning since crop trees are most subject to infection. In short, blister rust uncontrolled makes the growing of white pine an unprofitable venture except in the more southerly limits of its range in the United States where climatic factors seem to be impeding blister rust spread and development.

Blister rust is relatively harmless on Ribes bushes. Leaves are cast prematurely when infection is heavy and fruit production may be reduced.

Control measures and definition of problems requiring further research with reference to control

White pine blister rust is controlled by destroying ribes bushes growing in white pine stands and in a protective zone around them. This is possible because the fungus cannot spread from pine to pine but requires an alternation of host plants to complete its life cycle. By destroying the ribes, further spread and intensification is stopped.

Two distinct methods of destroying ribes are used: (1) digging or pulling the bushes by hand, or (2) spraying with herbicidal chemicals.

Silvicultural treatments, including judicious use of fire, is sometimes used to reduce and help maintain ribes populations at low levels in white pine stands.

Recently a major breakthrough in the control of white pine blister rust in western white pine stands has been accomplished. By applying certain anti-fungal antibiotics to the basal stem or foliage of infected western white pine trees, the blister rust fungus in them is killed. Two antibiotic fungicides have proven to be effective: (1) cycloheximide (trade name Acti-dione BR), and (2) Phytoactin. Cycloheximide has been used mainly for the basal stem treatment and Phytoactin for foliar treatments using aircraft to dispense it.

Still another approach to control, and of necessity a long-term one, is through selecting and breeding pines resistant to the rust. Substantial progress has been made in this field during the past ten years.

In the United States there are now 23 million acres in the white pine blister rust control area. Included in this area are 10½ million acres of the most valuable white pine lands and 12½ million acres in surrounding protective zones. Control has been established (ribes populations reduced to sufficiently low levels to prevent serious damage) on 18 million acres of this acreage. Principal remaining control work is in the western part of the United States in western white and sugar pine stands.

Some important research needs are listed as follows:

1. Development of effective formulations and application techniques of antibiotic fungicides on other white pine species.
2. Studies to determine the possible immunity to infection, and for how long, imparted by a single antibiotic application in the field and in the nursery.
3. Determination of how and why certain antibiotic fungicides kill blister rust infection in western white pine.
4. Development of silvicultural treatments which will reduce ribes populations and prevent their regeneration following cutting or other forest activity.

5. Continuation of studies to determine more precisely the role of climate in the spread and intensification of blister rust in the Sierra Nevadas of California and in the southern Appalachians in eastern United States.

6. Determination of the rust-resistance factor in certain individual white pines and the utilization of such information in accelerating the development of rust-resistant strains of white pine.

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SOUTHERN CONE RUST^{*}

Pathogen

Cronartium strobilinum (Arth.) Hedge. and Hahn.

Distribution

Southeastern United States along coast of Gulf of Mexico from Texas to Florida; also central Florida to south-central Georgia. Cuba.

Hosts

O, I on Pinus elliotii var. elliotii, P. elliotii var. densa, P. palustris.

II, III on Quercus virginiana, Q. virginiana var. geminata, Q. virginiana var. minima, Q. pumila, Q. nigra.

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